Lamellae formation and reorientation in diblock copolymers

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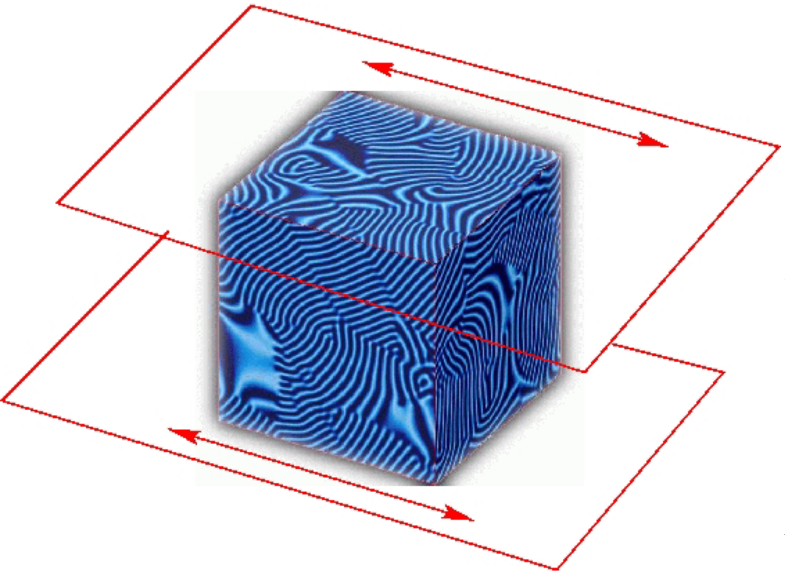
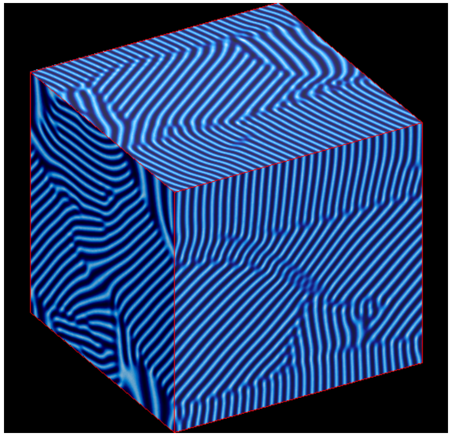


Diblock copolymers are macromolecules comprising two chemically distinct and mutually incompatible monomers that are covalently bonded (the composition of the binary shown schematically as blue and black in the figures). For a symmetric diblock mixture, a so called lamellar phase is observed in which nanometer sized layers of either type of monomer alternate in space. In practice, full development of the equilibrium structure (a single domain or grain of uniform orientation) requires processing times which are at least as long as the time required for substantial ordering at the scale of the size of the system; yet the underlying ordering rates of block copolymers are essentially unknown at present.



We investigate the mechanisms controlling the kinetics of large scale reorientation of lamellar domains, as well as the use of oscillatory shears (above) to accelerate domain coarsening (right), as this is the most widely used method to attempt to produce homogeneous macroscopic samples.

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With the transition to new technologies that increasingly rely on advanced materials microstructural control of mesophases has become necessary. Increased emphasis has been placed on their microstructure and self-assembly at the mesoscale. Just as examples, we mention the use of block copolymers either as nanolithographic templates, photonic band gap materials, light emitting diodes or dielectric mirrors, or as artificial membranes.

The challenge is to understand the origin of the characteristic relaxation times of the structure associated with the development of long ranged order (which is required for applications). Topological defects in a mesophase (three types shown right) are typically the longest lived modes, and hence understanding their motion and interaction is important to the overall dynamics of the mesophase.